

## Claims

1. A switching power supply circuit comprising:  
rectifying and smoothing means for generating a rectified and smoothed voltage, said rectifying and smoothing means including a rectifying device for rectifying an alternating input voltage and a smoothing capacitor for smoothing the voltage rectified by the rectifying device;

switching means for being supplied with the rectified and smoothed voltage generated by said rectifying and smoothing means and performing switching operation, said switching means being formed with two switching devices coupled by half-bridge coupling;

switching-driving means for switching-driving said two switching devices such that said two switching devices are turned on/off alternately;

an isolated converter transformer formed by winding a primary winding supplied with a switching output obtained by the switching operation of said switching means and a secondary winding in which an alternating voltage as the switching output obtained in the primary winding is induced, and forming a gap of a predetermined length so as to obtain a state of loose coupling with a required coupling coefficient;

a primary side series resonant circuit for being supplied with the switching output from said switching means and converting operation of said switching means into a current resonant type operation, said primary side series resonant circuit being formed by at least a leakage inductance component of said primary winding and a capacitance of a primary side series resonant capacitor connected in series with said primary winding;

direct-current output voltage generating means configured to generate a secondary side direct-current output voltage by receiving the alternating voltage obtained in said secondary winding and performing a rectifying operation;

constant-voltage control means configured to perform constant-voltage control on said secondary side direct-current output voltage by varying switching frequency of said switching means by controlling said switching-driving means according to level of said secondary side direct-current output voltage; and

a power factor improving transformer formed by winding a power factor improving primary winding inserted in series with said primary side series resonant circuit and a power factor improving secondary winding inserted in a rectifying and smoothing path formed as said

rectifying and smoothing means;

wherein the rectifying device of said rectifying and smoothing means performs switching operation on the basis of an alternating voltage induced in said power factor improving secondary winding by said power factor improving primary winding.

2. A switching power supply circuit as claimed in claim 1, wherein,

said rectifying and smoothing means is voltage doubler rectifying and smoothing means,

including two smoothing capacitors, that is, a smoothing capacitor for smoothing the voltage obtained by rectifying said alternating input voltage by the rectifying device in a positive period of said alternating input voltage, and a smoothing capacitor for smoothing the voltage obtained by rectifying said alternating input voltage by the rectifying device in a negative period of said alternating input voltage, and

formed such that a voltage obtained by accumulating voltages across said two smoothing capacitors is said rectified and smoothed voltage.

3. A switching power supply circuit comprising:

rectifying and smoothing means including a plurality of low-frequency rectifying devices for

rectifying an alternating input voltage in each positive/negative period of the alternating input voltage and a smoothing capacitor for smoothing the voltage rectified by the low-frequency rectifying devices;

switching means for being supplied with the rectified and smoothed voltage generated by said rectifying and smoothing means and performing switching operation, said switching means being formed with two switching devices coupled by half-bridge coupling;

switching-driving means for switching-driving said two switching devices such that said two switching devices are turned on/off alternately;

an isolated converter transformer formed by winding a primary winding supplied with a switching output obtained by the switching operation of said switching means and a secondary winding in which an alternating voltage as the switching output obtained in the primary winding is induced, and forming a gap of a predetermined length so as to obtain a state of loose coupling with a required coupling coefficient;

a primary side series resonant circuit for being supplied with the switching output from said switching means and converting operation of said switching means into a current resonant type operation, said primary side

series resonant circuit being formed by at least a leakage inductance component of said primary winding and a capacitance of a primary side series resonant capacitor connected in series with said primary winding;

direct-current output voltage generating means configured to generate a secondary side direct-current output voltage by receiving the alternating voltage obtained in said secondary winding and performing a rectifying operation;

constant-voltage control means configured to perform constant-voltage control on said secondary side direct-current output voltage by varying switching frequency of said switching means by controlling said switching-driving means according to level of said secondary side direct-current output voltage;

a power factor improving transformer formed by winding a power factor improving primary winding inserted in series with said primary side series resonant circuit and a power factor improving secondary winding connected in parallel with a predetermined rectifying current path formed as said rectifying and smoothing means; and

a plurality of high-frequency rectifying devices connected in series with said power factor improving secondary winding, for performing switching operation in

each positive/negative period of the alternating voltage induced in the power factor improving secondary winding by said power factor improving primary winding, said alternating voltage having a high frequency as compared with frequency of said alternating input voltage.

4. A switching power supply circuit as claimed in claim 3, wherein,

said rectifying and smoothing means is voltage doubler rectifying and smoothing means,

including two smoothing capacitors, that is, a smoothing capacitor for smoothing the voltage obtained by rectifying said alternating input voltage by the rectifying device in a positive period of said alternating input voltage, and a smoothing capacitor for smoothing the voltage obtained by rectifying said alternating input voltage by the rectifying device in a negative period of said alternating input voltage, and

formed such that a voltage obtained by accumulating voltages across said two smoothing capacitors is said rectified and smoothed voltage.

5. A switching power supply circuit comprising:

rectifying and smoothing means including a plurality of rectifying devices for rectifying an alternating input voltage in each positive/negative

period of the alternating input voltage and a smoothing capacitor for smoothing the voltage rectified by the rectifying devices;

switching means for being supplied with the rectified and smoothed voltage generated by said rectifying and smoothing means and performing switching operation, said switching means being formed with two switching devices coupled by half-bridge coupling;

switching-driving means for switching-driving said two switching devices such that said two switching devices are turned on/off alternately;

an isolated converter transformer formed by winding a primary winding supplied with a switching output obtained by the switching operation of said switching means and a secondary winding in which an alternating voltage as the switching output obtained in the primary winding is induced, and forming a gap of a predetermined length so as to obtain a state of loose coupling with a required coupling coefficient;

a primary side series resonant circuit for being supplied with the switching output from said switching means and converting operation of said switching means into a current resonant type operation, said primary side series resonant circuit being formed by at least a

leakage inductance component of said primary winding and a capacitance of a primary side series resonant capacitor connected in series with said primary winding;

direct-current output voltage generating means configured to generate a secondary side direct-current output voltage by receiving the alternating voltage obtained in said secondary winding and performing a rectifying operation;

constant-voltage control means configured to perform constant-voltage control on said secondary side direct-current output voltage by varying switching frequency of said switching means by controlling said switching-driving means according to level of said secondary side direct-current output voltage; and

a power factor improving transformer formed by winding a power factor improving primary winding inserted in series with said primary side series resonant circuit and a power factor improving secondary winding connected in parallel with a predetermined rectifying current path formed as said rectifying and smoothing means;

wherein the rectifying devices of said rectifying and smoothing means perform switching operation on a basis of an alternating voltage induced in said power factor improving secondary winding by said power factor



improving primary winding.

6. A switching power supply circuit as claimed in one of claims 1, 3, and 5, wherein,

a state of loose coupling at a required coupling coefficient is obtained between said power factor improving primary winding and said power factor improving secondary winding; and

to obtain a coupling coefficient of a required value or higher in said isolated converter transformer so as to correspond to a required coupling coefficient obtained as a coupling coefficient of said switching power supply circuit as a whole, the gap of said isolated converter transformer is set to a length within a predetermined value.

7. A switching power supply circuit as claimed in one of claims 1, 3, and 5, further comprising a primary side partial voltage resonant circuit formed by at least including a capacitance of a partial voltage resonant capacitor connected in parallel with at least one of said two switching devices and the leakage inductance component of said primary winding, said primary side partial voltage resonant circuit performing a voltage resonant operation only in accordance with timing of turning on or turning off of each said switching device.

8. A switching power supply circuit as claimed in claim 5, wherein,

said rectifying and smoothing means includes a circuit formed by four rectifying devices connected by bridge connection and two smoothing capacitors connected in series with each other such that said four rectifying devices connected by said bridge connection charge a series connection of said two smoothing capacitors with a rectified current obtained by full-wave rectification; and

said switching power supply circuit further includes

switch means inserted to switch on/off between said two smoothing capacitors and a line of an alternating current, and

switch control means for performing control to turn off said switch means when level of said alternating current is a reference value or higher, and turn on said switch means when the level of said alternating current is lower than the reference value.

9. A switching power supply circuit as claimed in claim 5, wherein,

said power factor improving primary winding is divided into two parts via a tap, and an end part of one

divided part of said power factor improving primary winding is connected to said primary side series resonant capacitor; and

said switching power supply circuit further includes

switching means for performing switching to select an end part of the other divided part of said power factor improving primary winding and a terminal of said tap as a part to be connected to an end part of the primary winding of the isolated converter transformer, and

switching control means for performing control to make said switching means select the end part of the other divided part of said power factor improving primary winding when level of said alternating current is a reference value or higher, and make said switching means select the terminal of said tap when the level of said alternating current is lower than the reference value.